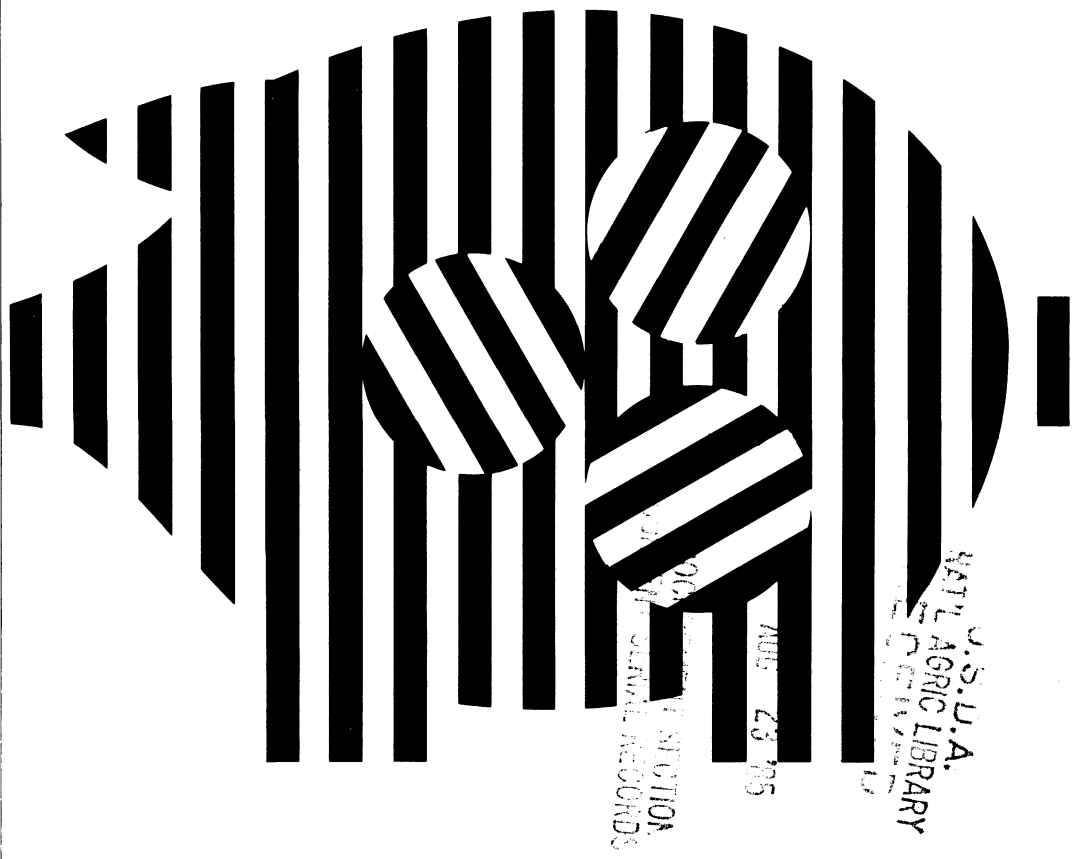
Preventing and Controlling Internal Parasites of Hogs



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CONTENTS

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Preventing and Controlling

Internal Parasites of Hogs

Hogs are susceptible to infection with many species of internal parasites. These parasites vary widely in structure, size, shape, habits, life history, and in the degree of their injury to hogs.

Internal parasites may occur in almost every part of the hog. Eggs and larvae—stages that exist outside the hog—survive best under unsanitary conditions.

A single species of parasite may cause a heavy infection. Hogs usually harbor several species at the same time.

Infected hogs may not be noticeably sick. However, some become unthrifty because parasites sap their vigor, stunt growth, and injure vital organs. Parasites may also increase susceptibility to other diseases. Parasites are usually more harmful to young pigs than to older animals.

For good growth and development, hogs need adequate amounts of proper feed, clean surroundings, and relative freedom from parasites. Parasite-free pigs grow faster, fatten on less feed, and often go to market earlier than infected pigs.

Internal parasites fall into the following groups:

- Roundworms. Roundworms are relatively slender cylindrical worms, attenuated at both ends. They cause more damage to hogs in the United States than any other group of internal parasites. Roundworms include large intestinal worms (ascarids), stomach worms, intestinal threadworms, kidney worms, lungworms, nodular worms, whipworms, trichinae, and thorn-headed worms.
- Tapeworms. Only bladder worms—incompletely developed tapeworms—are found in hogs.
- Flukes. Flukes are soft, leaflike worms.
- Protozoa. These very small one-celled parasites can be seen only with a high-powered microscope.

For information about external parasites or bacterial and other diseases of hogs, contact your county agricultural agent or your State agricultural experiment station or write to the U.S. Department of Agriculture, Washington, D.C. 20250.

This publication briefly describes and discusses the common internal parasites of swine. It also gives methods of prevention, control, and—when practical—suggestions for treatment.

DAMAGE

Internal parasites cause unthriftiness—a state in which the infected pig is neither well nor definitely sick. Heavy infections may cause weakness, emaciation, and diarrhea.

Young pigs are highly susceptible to internal parasites. They lack the hardiness to cope with disease-producing invaders. Many young pigs die from parasitic infections.

Internal parasites may occur in the digestive tract, lungs, liver, kidneys, muscles, and occasionally in the bloodstream. Immature forms of some species wander through the hog's body after infection occurs. Mass migrations often injure vital organs, particularly in young pigs.

Some skin disorders may be associated with parasitic infections.

Under Federal meat inspection, visibly damaged parts—livers, kidneys, hearts, intestines, and other organs—are condemned for use as human food unless the infected tissue can be completely removed by trimming. When the infection is widespread, the entire carcass may be condemned.

SPREAD

Pigs acquire parasites in the following ways:

- By eating feed or soil contaminated with the infective stages.
- By eating earthworms or beetles that contain the infective stages.
- By invasion of young (larval) worms through the skin.

Parasite eggs and larvae can survive for many months under favorable conditions. Sunlight and drying are unfavorable to parasites in soil.

Parasites, eggs, and larvae are spread by—

- Infected hogs. These hogs discharge parasite eggs with feces or urine.
- Contaminated environment—shelters, moist and shaded areas of pastures and hog lots.
- Contaminated feed and water.
- Intermediate hosts—such as earthworms and dung beetles in which certain internal parasites must develop to become infective.

Once the parasites in the hog become mature, the hogs contaminate the environment with parasite eggs. Infected animals may retain many internal parasites throughout life. Some species can be removed by proper medication.

PREVENTION AND CONTROL

Both parasite prevention and parasite control involve the protection of pigs from internal parasites.

Prevention involves keeping "clean" pigs from becoming infected or reinfected. Treatments can be used to remove parasites from the intestines and relieve the stress on the pig.

Prevention is the best—and in the long run, the cheapest—way to deal with internal parasites. A little well-directed energy spent in protecting pigs from parasites is far more effective than medication.

Cleanliness, or sanitation, is vital

to the prevention of parasites. If young pigs are raised in clean surroundings, are properly fed and housed, and are separated from older hogs, there is little chance they will become seriously infected.

Housing and Pasture

Start with farrowing and hog houses built of easy-to-clean materials. Sweep and hose down or scrub the floors often enough to prevent accumulation of manure, litter, and filth.

Provide clean pastures, feeding grounds, and hog lots. Clean up—or get rid of—filthy hog lots where parasites can survive. Make sure pastures are properly drained, and fence wet areas to keep hogs out.

Use temporary pastures with suitable forage. The pasture should have been cultivated and planted to a new crop if it was last grazed by hogs.

If permanent pasture must be used, select a well-drained area that has not carried hogs for at least 1 year.

Separation From Older Hogs

In parasite prevention—as well as in control—pigs must be kept from all sources of infection. One way to do this is to separate each new litter and its sow from other hogs on the premises. Then keep hogs of similar ages together.

Preventive measures can be used to guard against reinfection.

Swine-Sanitation System

Sanitation is the key to a practical management system for controlling internal parasites of hogs.

The swine-sanitation system described here, which was developed by USDA scientists, is effective against many parasites.

The system is based on research findings about roundworms (ascarids), the most injurious and widespread parasite of hogs. Under farm conditions, the system will control many other internal parasites.

The system—as described—can be used with permanent farrowing houses in the Northern and Central States for spring-farrowed pigs. A permanent farrowing house may not be needed in these States in the fall, or in the South in either fall or spring.

The swine-sanitation system involves:

Cleaning farrowing pens.—The permanent farrowing house and its farrowing pens should be built of materials that are easy to keep clean. Before farrowing time, thoroughly clean the pens by removing all manure and other litter. Clean the floors, walls, troughs, and guardrails with hot water and lye. Use very hot water or steam to destroy parasites. Lye helps to remove dirt and to kill parasites. If farrowing pens are not heated, clean them in the fall before freezing weather; keep them closed and empty until time for use.

Cleaning the sow.—A few days before farrowing time, carefully wash each sow with soap and warm water to remove all mud and dirt on the skin. Wash udders and feet particularly well If there are worm eggs in the mud and dirt clinging to the sow's udders, newborn pigs are likely to swallow infectious material with the milk.

Using farrowing pens.—As soon as sows are cleaned, place them in the clean farrowing pens. Keep all other hogs out of farrowing pens; do not move newborn pigs unnecessarily. Leave sows and pigs in pens until the milk diet of the young pigs is supplemented with grain or pasture.

Preparing the pasture.—Select a temporary pasture planted to a legume or other suitable forage crop. Provide a shelter house for each sow and her litter. Have a clean water supply.

Moving to pasture.—Truck sows and their litters from the farrowing pens to pasture. First, wash the truck bed and put down a layer of clean straw. Do not walk pigs across old hog lots or permanent pastures. After weaning the pigs, haul them to another clean pasture.

Keeping pigs isolated.—Keeping pigs away from all possible sources of

GENERAL RECOMMENDATIONS FOR PARASITE PREVENTION AND CONTROL

The following measures are recommended to prevent or control internal parasites in hogs:

- Provide clean housing, clean pastures, and clean surroundings for all hogs. Do not let filth, trash, and litter accumulate.
- Isolate each litter of pigs from older hogs, except their dams. After weaning, keep pigs of similar ages together.
- Use temporary pastures that are well drained and are sown to suitable forage crops. Fence low, wet areas.
- Provide adequate supplemental feed to minimize the effects of parasitism.
- Follow a swine-sanitation management program to keep pastures free of parasite eggs and larvae (see p. 5).
- Ring noses of pigs on pasture to prevent rooting.
- Use specific medication, if recommended, to treat infected breeding stock and other hogs on the premises. (See treatment sections, pp. 7 to 35.) For some internal parasites, however, no effective treatment is available.
- Cook garbage as required by law before feeding it to hogs. This will kill parasites, eggs, and larvae.
- Use sanitary sewage disposal methods or sanitary privies on farms and in rural communities.
- Keep dogs off hog pastures, if possible.
- Treat dogs periodically to remove tapeworms.

NOTE: A number of the parasites that infect hogs are transmissible to man. These include tapeworms (pork bladder worm and hydatid), large intestinal roundworms or ascarid, trichinae, and perhaps dysentery-producing Protozoa. To safeguard human health, follow the general sanitary measures given above as well as specific measures suggested in sections on parasite prevention and control (pp. 4 to 35).

parasites is the main thrust of the swine-sanitation system. Failure to keep pigs isolated will virtually nullify benefits.

Restrict pigs to the clean areas; make sure no other hogs have access to the pasture. Keep pigs on clean pastures or in clean houses under sanitary conditions until they are ready for market.

Modifications for South.—In the South, transfer pregnant sows to clean temporary pastures that are equipped with simple, inexpensive A-type farrowing houses (fig. 1) and a clean water supply.

Modifications for fall farrowing.—In the Northern and Central States, sows farrowing in cold weather may be moved without washing into individual farrowing houses as described under Modifications for South.

TREATMENT

Treatment of infected swine to remove parasites should be combined with—not substituted for—proper sanitation. Treated pigs can become reinfected if kept in contaminated areas.

It's a good idea to consult a veterinarian when possible before treating hogs for parasites. Your veterinarian can diagnose the type of infection, determine whether treatment is practical, and decide when it should be given for best results. He can prescribe and administer drugs himself, or instruct you about drug use, dosage, and method of administration.

Treatments mentioned in this bulletin are for specific parasites.

Because most drugs are toxic, they may temporarily harm the hog as well as the parasites. Therefore, dosages recommended by the manufacturer are at rates that cause the greatest damage to parasites and the least possible injury to the hog.

Some of the drugs named can be used for treating an entire herd at one time. This reduces the need for individual dosing.

Piperazine, hygromycin, and

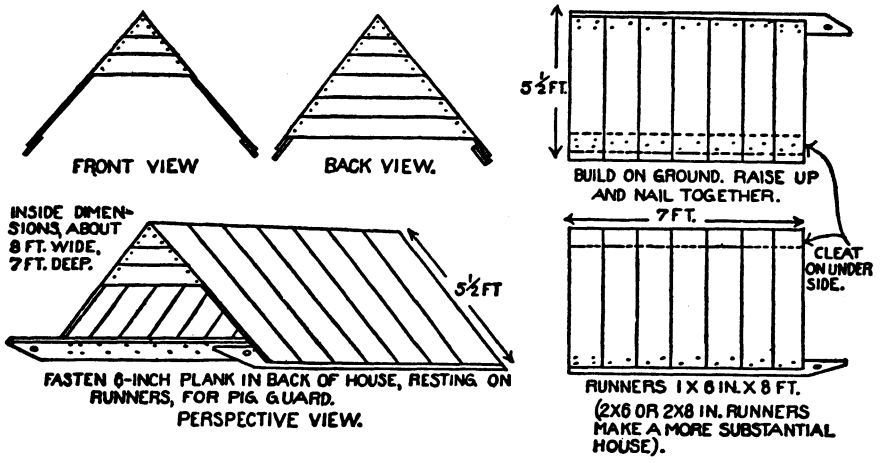

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Figure 1.—Individual portable farrowing house suitable for use in the South.

dichlorvos can be used against several species of parasites.

No single drug or combination of drugs will remove all internal parasites. There are no established treatments for some of the parasites that infect hogs.

The mere fact that treated pigs expel worms does not prove that the treatment was completely effective. Hogs can pass worms and still harbor many more. It is impossible to determine how many parasites remain in a live hog after treatment. This can be ascertained only by post mortem examination.

Drugs named in this bulletin should be used according to the manufacturer's directions or as prescribed by your veterinarian.

ROUNDWORMS

Roundworms vary in size. Some mature worms are as thin as a fine silk thread and only 1/6 inch long. The largest roundworm of hogs is as thick as a lead pencil and 10 or more inches long.

Some names describe the shape of the worm—for example, whipworm; other names identify the organ in which the worm is usually found—for example, stomach worm. Most roundworms live in the digestive tract. Others live in the lungs, liver, kidney, muscles, or elsewhere in the body.

Roundworms discussed in this bulletin—except trichinae—produce microscopic eggs. These eggs are passed in the feces or urine of infected hogs.

Different species of roundworms develop to the infective stage in different ways.

Eggs of some roundworms hatch on the ground. The newly emerged worms, or larvae, then must undergo development before they become infective. These free-living stages are too small to be seen without a magnifying glass.

Eggs of other roundworms develop to the infective stage and hatch after swallowing.

Some roundworm eggs must be swallowed by intermediate hosts—usually insects or earthworms—before they reach the infective larval stage. Hogs become infected with these worms after swallowing infected intermediate hosts.

The Large Intestinal Roundworm, or Ascarid

The large intestinal roundworm, or ascarid, *Ascaris suum*, is yellow or pink; adults are around the size of a lead pencil (fig. 2) or larger.

Adult ascarids normally live in the small intestine. Under some conditions, they may wander into the stomach, bile ducts of the liver, gall bladder, pancreas, and parts of the body connected with the gut. The young worms migrate—by way of the bloodstream—through the liver, lungs, and into other organs and tissues.

Life history

A full-grown female ascarid may contain 26 to 27 million eggs at one time. Eggs are eliminated in feces.

These eggs are not infective at first, but under favorable conditions of temperature and moisture, they may reach the infective stage in 3 or 4 weeks. Under cold, dry, or other unfavorable conditions, these eggs may take several months to develop.

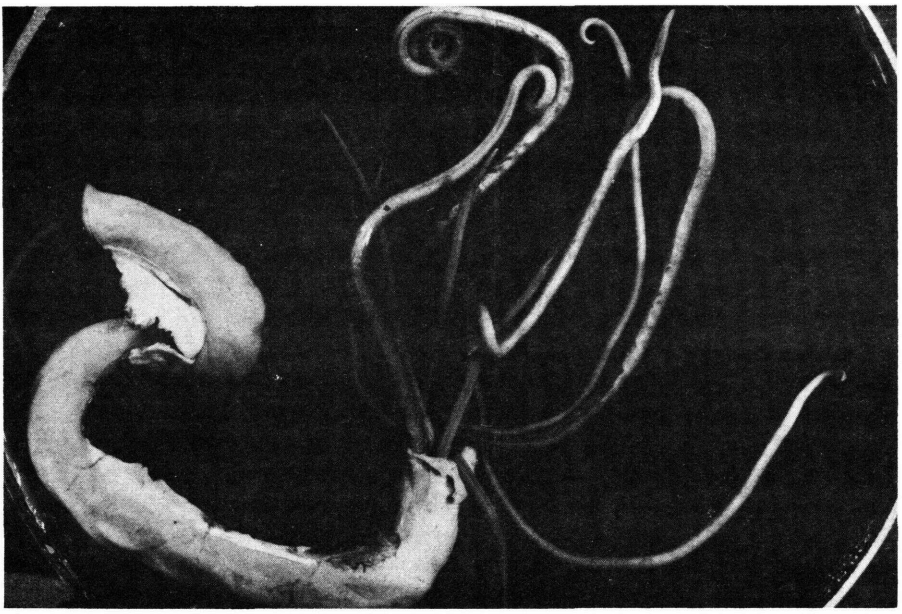

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Figure 2.—Large intestinal roundworms (ascarids). Some worms are protruding from the small intestine.

Pigs become infected by swallowing the infective eggs with feed or water. Ascarid eggs are abundant on hog lots, pastures, and other places contaminated with feces of infected hogs.

Young worms escape from the eggshells into the pig's intestine, penetrate the intestinal wall, and travel in the bloodstream first to the liver, then to the lungs. After getting into the air spaces of the lungs, they migrate up the branches of the windpipe to the throat and are swallowed. In the intestine, they mature and begin to lay eggs (fig. 3).

Damage

In pigs ascarids may retard growth and cause general unthriftness and digestive disturbances. Severely affected young pigs may die. Infected pigs also become more susceptible to other disease agents.

If the young ascarids make their curious roundabout journey (fig. 4) in large numbers, the liver and lungs of the pig may be severely damaged. Some pigs breathe with difficulty and a few may die of pneumonia. Probably many cases of thumps in young pigs are caused by ascarid migrations through the lungs. Many pigs with ascarid-damaged lungs fail to develop at a normal rate.

When the diet is inadequate, infected pigs may become anemic, develop colic, and—occasionally—have convulsions.

Although larva-damaged livers and lungs usually heal, the liver is sometimes permanently affected. Whitish scars may form over the entire surface of the liver (fig. 5). In some lots

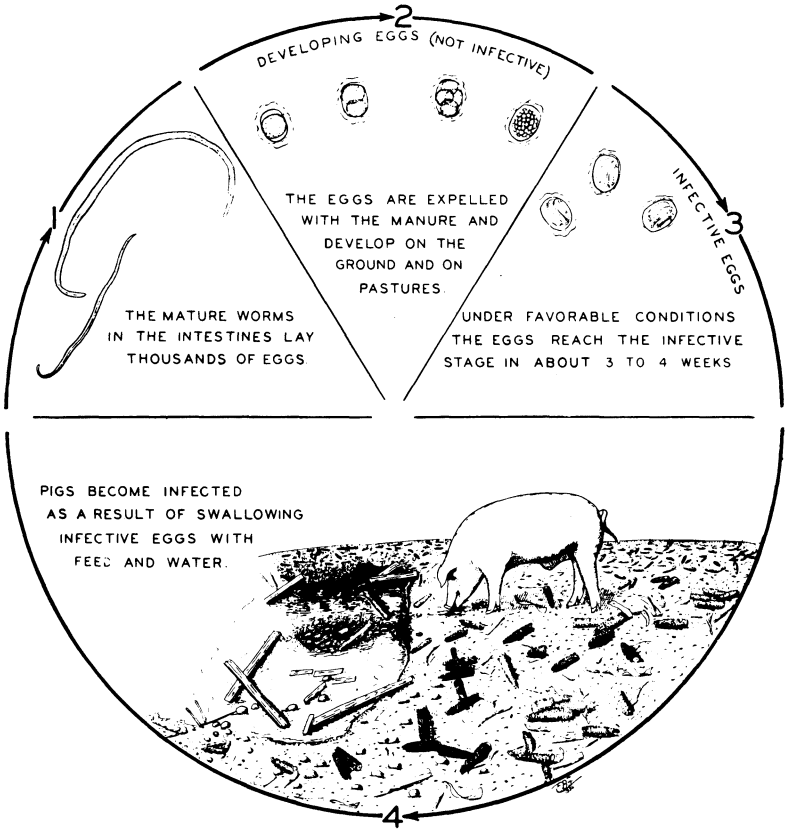

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Figure 3.—Life cycle of large intestinal roundworm (ascarid).

of infected hogs, one-third of the livers show ascarid damage.

Treatment

Piperazine, hygromycin, dichlorvos, pyrantel tartrate, levamisole, and thiabendazole may be used to remove large roundworms. Commercial products containing these chemicals should be used according to the specific directions on the label.

For treating a group of pigs, piperazine is usually given in feed or drinking water. It may also be given to individual pigs in capsules, by stomach tube, or by dose syringe. Dosages recommended for large roundworms also are effective against nodular worms (p. 21).

Hygromycin is given to growing pigs in the regular ration for at least 5 weeks. This drug is effective against large roundworms, nodular worms, whipworms, and perhaps other parasites.

Dichlorvos is given in dry meal-type feed to groups of similar-sized pigs. It is effective against large roundworms, nodular worms, and whipworms.

Pyrantel tartrate is given as the

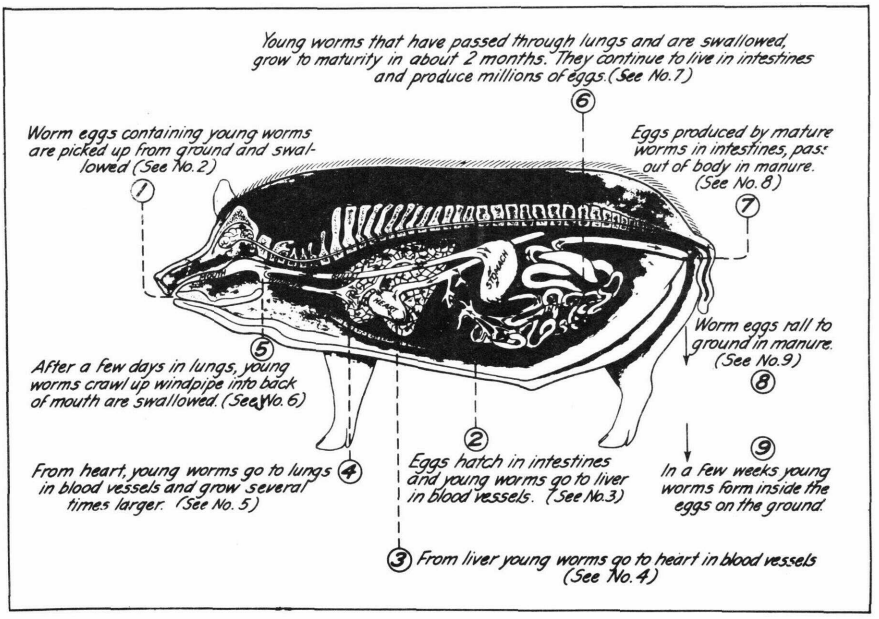

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Figure 4.—The roundworm's journey through the pig.

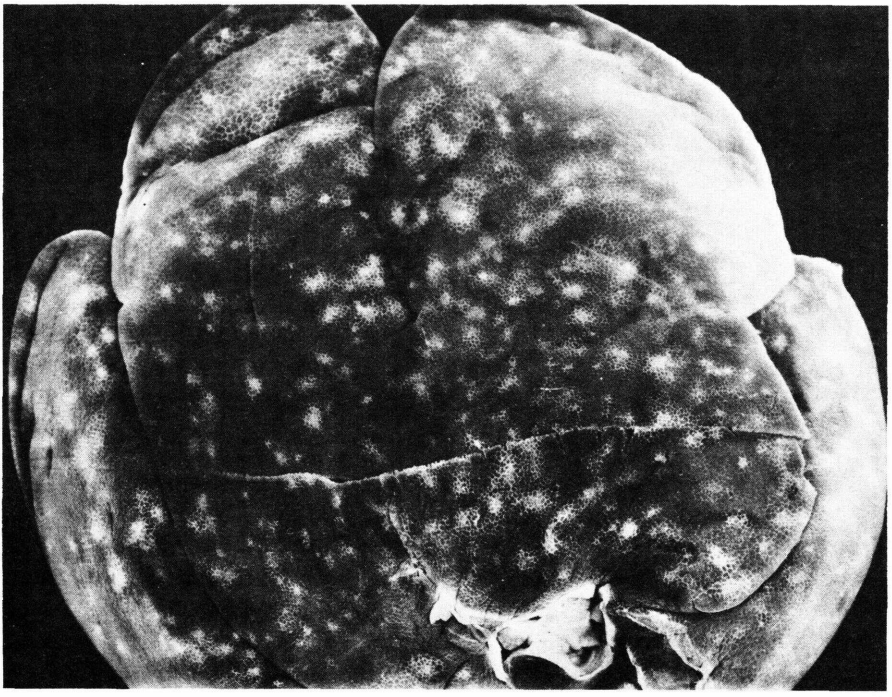

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Figure 5.—Scars produced by migrating ascarid larvae in a liver.

sole ration in a complete feed. It is effective against large roundworms and nodular worms.

Levamisole hydrochloride is given as an additive to the feed or to the drinking water. It is effective against large roundworms, nodular worms, lungworms, and threadworms.

Thiabendazole is given as a feed additive. It is effective against large roundworms.

Control

To control ascarids in pigs, follow the swine-sanitation system (p. 5).

The ascarid that infects humans is closely related to the large intestinal roundworm of hogs. In man, this parasite undergoes migrations similar to those in the pig. Larvae of the pig roundworm will migrate to the lungs of man and produce serious damage. Children playing in areas to which pigs have access may pick up ascarid eggs by putting soiled fingers in the mouth or eating fruit that has fallen to the ground.

Stomach Worms

Hogs harbor three species of stomach worms.

The red stomach worms, *Hyostrongylus rubidus*, is a small, delicate, reddish, threadlike worm. It is normally 1/5 to 1/3 inch long and 1/250 inch wide.

The other two species are thick stomach worms (fig. 6) grossly similar in appearance. Both species, *Ascarops strongylina* and *Physocephalus sexalatus*, are whitish or reddish. The worms are 1/5 to 1 inch long and 1/80 inch wide.

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Figure 6.—Thick stomach worms on the inner surface of a hog's stomach. (Natural size.)

Life history

These worms deposit eggs that are eliminated in the feces. Under favorable conditions, the eggs hatch within a few days and the larvae develop to the infective stage in about a week.

Young pigs become infected with red stomach worms by swallowing feed or water contaminated with the infective larvae.

Dung beetles are intermediate hosts of thick stomach worms. These beetles swallow the worm eggs when they feed on infected feces. In turn, pigs become infected when they eat the infected beetles.

Damage

Stomach worms contribute to the general emaciation and digestive disturbances of parasitized hogs. In infected hogs, there is usually excess mucus on the stomach wall. Thick stomach worms are usually found between a thick mucouslike false membrane of the stomach wall and the stomach proper. Young worms may penetrate the stomach wall and interfere with digestion.

Treatment

Dichlorvos is effective in removing the thick stomach worm.

Carbon disulfide is effective in removing both red and thick stomach worms. Keep all feed from animals for 18 to 24 hours before treatment. Food in the stomach reduces the effectiveness of the treatment by interfering with the drug's action. Carbon disulfide may be given in capsules or by stomach tube. Use 2 to 2-1/2 fluid drams (8 to 10 cubic centimeters) per 100 pounds of live weight.

Control

Follow the swine-sanitation system (p. 5) to control the red stomach worm.

Keep hogs out of old hog lots, straw piles, and permanent pastures where dung beetles live.

The Intestinal Threadworm

The intestinal threadworm, *Strongyloides ransomi*, infects hogs of all ages, but is particularly injurious to young pigs. Threadworms persist for a long time, but the number may gradually decrease after pigs are weaned.

All the parasitic adults are female. These fine, delicate, whitish worms are about 1/6 inch long and 1/30 inch wide. They live in the small intestine of the infected pig.

Life history

Threadworm eggs are eliminated in the feces and hatch within a few hours under favorable conditions. The larvae may develop in one of two ways. Some grow directly to a stage that is infective to pigs. Others develop into males and females. After mating, females produce eggs that hatch within a few days. The larvae from these eggs then develop to a stage infective to hogs.

Hogs become infected when they eat feed contaminated with larvae or when the larvae penetrate their skin.

Damage

Pigs with heavy infections have diarrhea, lose their appetites, and may become stunted.

Threadworm larvae invade muscles and vital organs as they wander in the body. Pigs—and sows weakened from suckling their litters—may die from larvae in the heart, brain, spinal cord, or other organs.

Treatment

Levamisole is effective for removal of lungworms from hogs.

Thiabendazole has shown promise under experimental conditions. No practical recommendations for farm use have been developed.

Control

Keep sows and pigs in clean quarters with clean bedding. Avoid hog lots and old pastures.

The Swine Kidney Worm

The swine kidney worm, *Stephanurus dentatus*, is a thick black-and-white mottled parasite. When full grown, it is 1 to 2 inches long and 1/20 to 1/10 inch wide (fig. 7). Kidney worms are most prevalent in the Southeastern States.

The mature worm lives in cysts in the walls of the ureters—the slender tubes that connect the kidneys with

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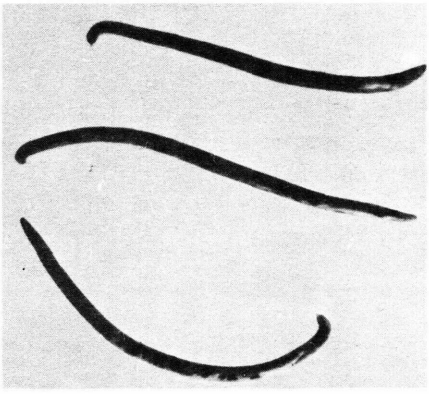

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Figure 7.—Kidney worms. (Slightly enlarged.)

the bladder—or in the kidney tissue. Young worms invade the liver soon after infection. They often occur in the large blood vessels that lead to the liver; they may also be found in the abdominal cavity, fat surrounding the kidneys, the loin muscles, and in the lungs. They may occasionally occur in the muscles of the hind legs. They have been found in the spinal canal.

Life history

Female kidney worms produce large numbers of microscopic eggs, which move through the ureters to the bladder and are discharged in the urine.

With favorable temperatures, shade, and moisture, eggs on bare soil or on pasture hatch in 1 or 2 days. Larvae become infective in about a week.

Eggs and larvae may be killed by sunlight, drying, and freezing. Pastures and lots that have accumulated litter, abundant shade, and some moisture are ideal for kidney worms. They can survive in such places for several weeks. In experiments, kidney worm larvae have survived in earthworms for more than a month.

Pigs get kidney worms by swallowing infective larvae with contaminated forage or other feed, or while rooting. These larvae may also penetrate the skin of a pig lying down on contaminated pastures and lots. Heat of the pig's body stimulates the larvae to penetrate the skin.

Once in the pig's body, the young worms migrate to the liver, lungs, and other organs. In the liver, the young worms bore through the blood vessel walls and wander in the tissue. Some kidney worms migrate in the abdominal cavity; some become trapped in muscles and other organs; some lodge in the relatively soft kidney fat or the kidney tissue. The worms are also found in pockets in the wall of the ureters. Eggs produced by the females are expelled with urine.

The kidney worm develops slowly; it takes 9 to 12 months for female to reach the egg-laying stage (fig. 8).

Damage

There are no especially characteristic signs of kidney worm infection. Urine of infected pigs sometimes contains pus. Pigs may show unthriftiness and arrested development associated with general parasitism. Paralysis of the hindquarters has been associated with kidney worms in the spinal canal (fig. 9). Most paralysis, however, is due to other causes.

Kidney worms cause serious damage in the tissues and organs they invade. The principal injury involves the liver: kidney worms leave bloody tracks when they migrate through the

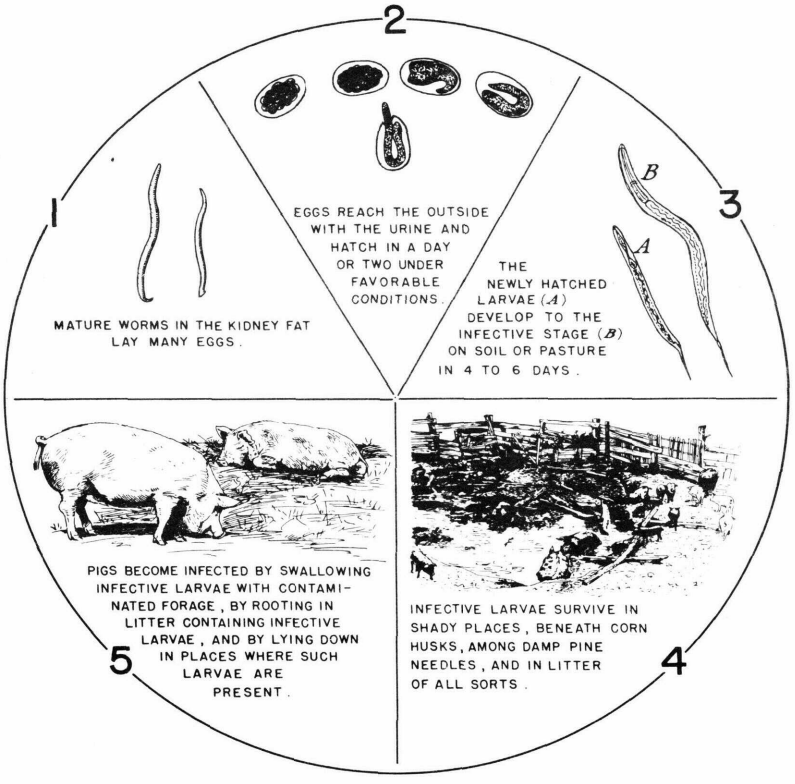

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Figure 8.—Life cycle of kidney worms.

liver and perforate its capsule. As healing occurs, hard, grayish-white scars develop (fig. 10). These characteristic scars may be small, circumscribed, and superficial, or they may be large and deep. Pus may be present in some lesions.

Kidney worms may damage loin muscles (fig. 11). They may also cause nodules in the lungs and thickening of the ureter walls.

Under Federal meat inspection, damaged livers are condemned, or the affected areas are removed by trimming. When kidney worm infection occurs throughout the body, the entire carcass may be condemned.

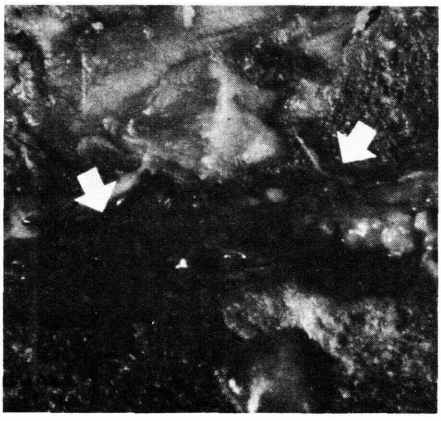

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Figure 9.—Kidney worms (arrows) in hog's spine. (Spinal canal has been cut open to show worms.)

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Figure 10.—Scars (whitish areas) produced by kidney worms in a hog's liver.

Treatment

There is no approved treatment to remove kidney worms: however, treatment with levamisole has shown promise. Consult your veterinarian for information on use.

Prevention

To prevent kidney worms, keep pigs from coming in contact with all sources of infection.

Control

Proper herd management and sanitation can free contaminated pastures of kidney worms in 12 to 18 months.

Two methods have been successful. Both methods protect pigs from

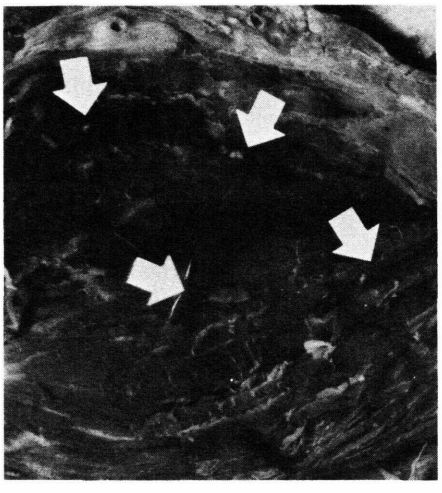

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Figure 11.—Infected loin muscle, which has been cut open to shown kidney worms (arrows). (Natural size.)

infection while making use of natural barriers to break the kidney worm life cycle.

METHOD 1:

- Limit the breeding herd to gilts farrowing their first litters. Follow this procedure for at least three consecutive semiannual farrowings. Slaughter the gilts when their pigs are weaned.
- Replace the herd with gilts or sows raised by this method.
- Keep the hog lot and pasture free of trash and litter. Cleaning up shady areas will expose eggs and larvae to drying; sunlight will kill them.
- Provide good drainage for pastures. Make sure that temporary pastures are located where they will not be contaminated by runoff from kidney worm-infested premises.

METHOD 2:

- Prepare a temporary pasture by sowing it to a suitable forage crop. (See swine-sanitation system, p. 5 .)
- Provide a bare area about 30 feet wide at one end of the pasture (fig. 12) to accommodate shelters, feed, and watering devices. If possible, maintain a bare area 3 to 5 feet wide around the rest of the pasture. Keep this area free of grass, weeds, trash, and litter.

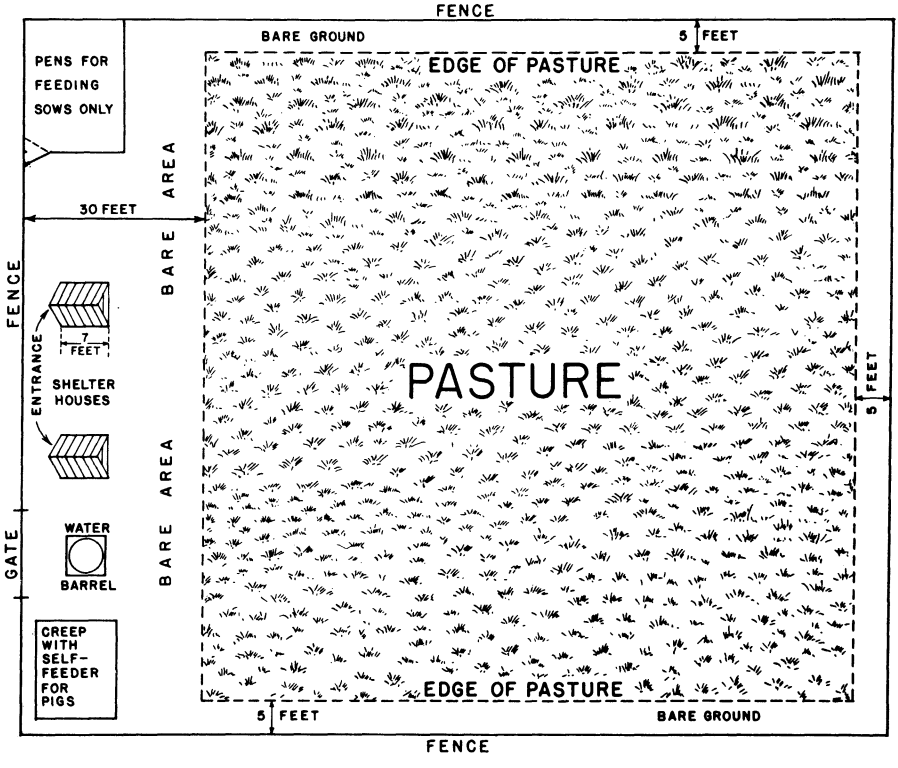

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Figure 12.—Kidney worm control plan.

- Use a creep with self-feeder for pigs.
- Provide a separate feeding pen for sows. Keep the gate of the sows' feeding pen closed. Open it only to admit sows for feeding. Move sows out of the pen about an hour after they feed. Because sows often urinate soon after feeding and drinking, many kidney worm eggs will be deposited in the feeding pen. These eggs will not be available to the young pigs that are kept out of the pen.
- Place pregnant sows, shortly before farrowing, on the temporary pasture.
- Wean pigs early. Move them to another clean temporary pasture that has not been occupied by hogs for at least 6 months. This will help prevent infection from kidney worms after pigs are weaned.

Although sows may contaminate the pasture and the bare area, the number of kidney worm eggs that hatch will be reduced. If this method is followed, the infestation will gradually die out.

Lungworms

Three species of lungworms infect hogs. *Metastrongylus apri* and *M. pudendotectus* are among the most widespread parasites of hogs. They occur in all parts of the United States. *M. salmi* is usually found in the South.

All three species are long, slender, whitish worms. They may be as long as 2 inches and about 1/50 inch wide (fig. 13).

Lungworms live in the smaller branches of the air passages.

They cause injury in proportion to the number of worms present. These worms sometimes serve as carriers of swine influenza.

Life history

Female lungworms produce large numbers of eggs, which are coughed up, swallowed, and eliminated in the feces.

Earthworms are the intermediate hosts of lungworms. They swallow the eggs; the eggs hatch and the larvae develop to the infective stage.

Pigs acquire lungworms by swallowing infected earthworms. A single earthworm may harbor 2,000 or more lungworm larvae—enough to produce a heavy infection.

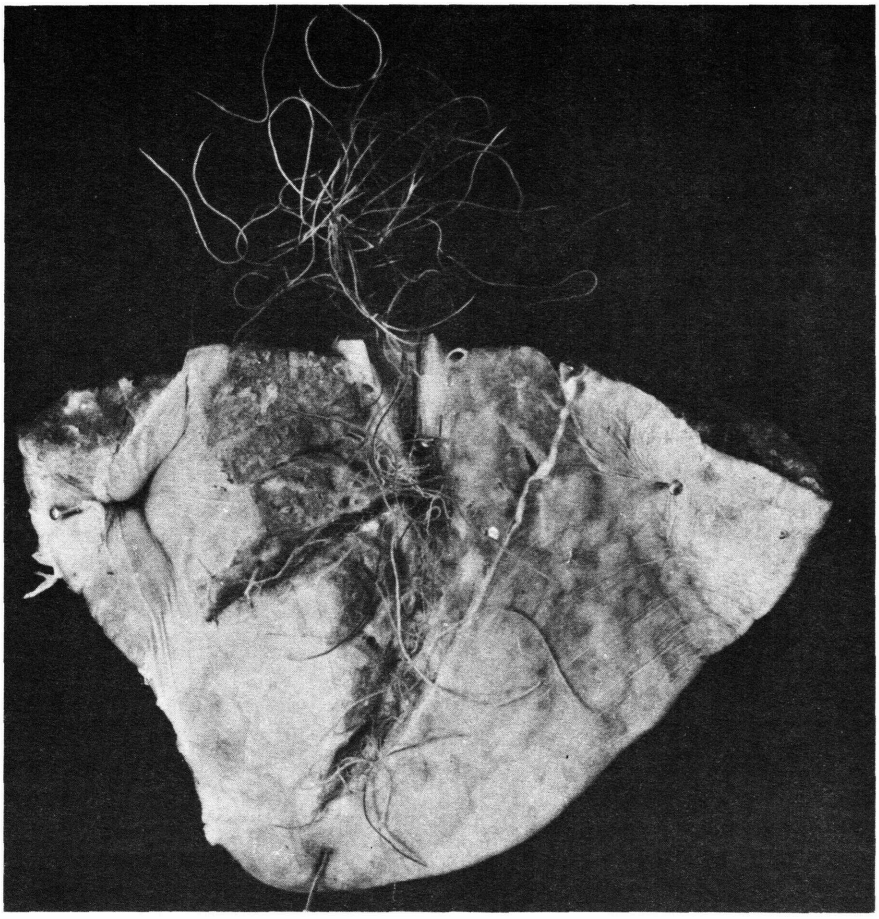
In the pig's alimentary canal, the lungworm larvae are freed by digestion of earthworms. The young lungworms penetrate the intestinal wall; they are carried by the lymph to the heart and then by the bloodstream to the lungs.

In about 4 weeks, the lungworms begin producing eggs, which are coughed up, swallowed, and are eliminated in the feces. These eggs can infect other earthworms (fig. 14).

Damage

Signs of lungworms in young pigs include coughing, difficult breathing, loss of appetite, weakness, and failure to grow. Pigs may die from the infection. In older pigs, coughing and shortness of breath are the outstanding signs. Heavy infections may be marked by a localized pneumonia, caused when the branches of the lungs are plugged with worms.

During the early stages of invasion, lungworms perforate the walls of delicate blood vessels. Affected lungs appear peppered with hemorrhages. Later the tips of the lungs develop



BN-28212

Figure 13.—Nests of lungworms in hog's lung (bottom): lungworms removed to show size and shape (top).

gray, hardened areas that mark the location of worms.

Treatment

Levamisole is effective for removal of lungworms from hogs. As soon as you see signs of lungworms, take infected pigs off the contaminated pasture or out of the lot where they acquired lungworms. Move them to a clean, dry pen with concrete floor. Give them milk, nutritious feed, and clean drinking water. Renew bedding and clean the pen often.

Control

To control lungworms in pigs, follow the swine-sanitation system (p. 5). For pasture, use well-drained fields on which crops are cultivated seasonally; these contain comparitively few earthworms. Keep pastures clean and free of litter. Ring pigs' noses.

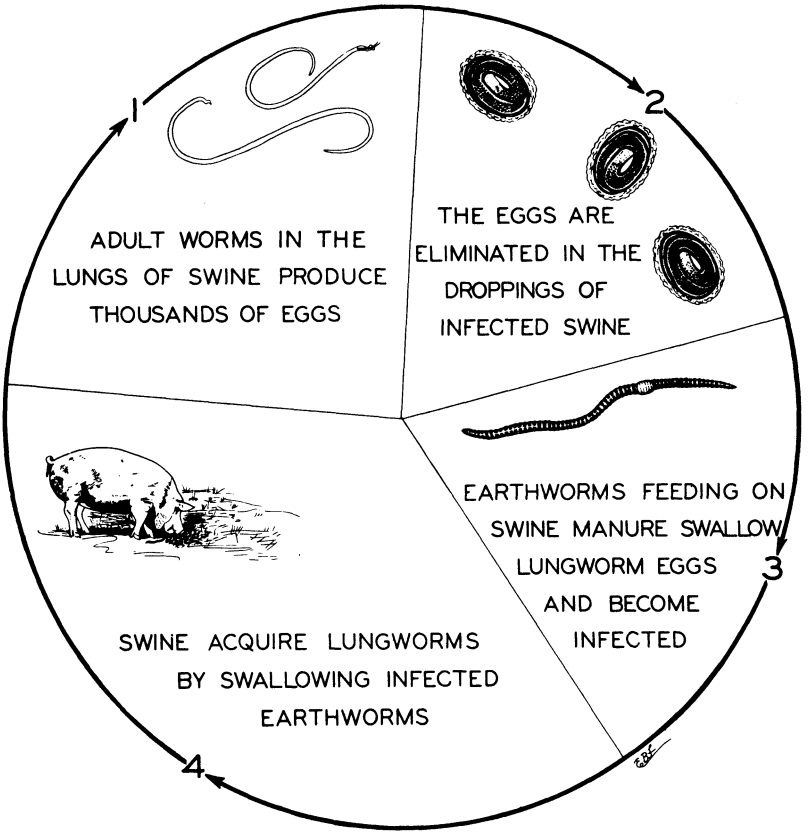


Figure 14.—Life cycle of lungworms. BN-28223

NODULAR WORMS

Four species of nodular worms infect hogs in the United States. The common nodular worm, *Oesophagostomum dentatum*, is found in practically all parts of the country. The long-tailed nodular worm, *O. quadrispinulatum (O. longicaudum)*, and the short-tailed nodular worms, *O. brevicaudum* and *O. georgianum*, are usually found in the South.

Adults are slender, whitish or grayish worms, 1/3 to 1/2 inch long and 1/100 inch wide (fig. 15). They live in the blind gut and large intestine of infected pigs.

Life history

Female worms in the intestine produce large numbers of eggs, which are discharged in the feces. Under favorable conditions, the eggs hatch in a day or two. Newly hatched larvae develop to the infective stage in about a week.

Susceptible pigs become infected by swallowing infective larvae in contaminated feed or soil. Larvae pene-

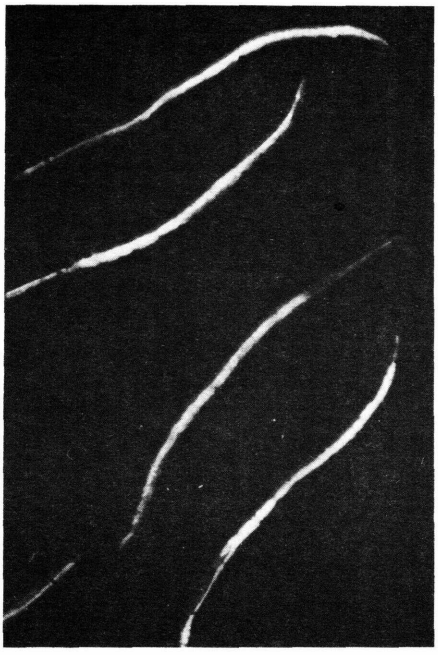


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Figure 15.—Nodular worms. (Slightly enlarged.)

trate the wall of the large intestine; in heavy infections, the wall becomes peppered with small elevations, or nodules. Each nodule contains a young worm (fig. 16).

Eventually the worms leave the nodules and migrate to the cavity of the blind gut and the large intestine. Here they attain full growth and sexual maturity in about 2 months.

Damage

Signs of nodular worm infection include unthriftiness, weakness, diarrhea, and sometimes anemia. Because these signs are also produced by many other internal parasites, it is not possible to diagnose nodular worms from signs alone.

A nodule caused by the common nodular worm is usually about the size of a pinhead. A nodule produced by the long-tailed worm may be much larger, and conspicuously raised above the surface of the inner lining of the intestinal wall. Often, a nodule becomes highly inflamed. It may ulcerate producing an open sore containing dead tissues, bacteria, and pus.

Treatment

Piperazine, hygromycin, dichlorvos, pyrantel tartrate, levamisole, and phenothiazine are effective treatments for nodular worms. In using these drugs, follow recommendations on container labels in addition to those on page 6 .

Phenothiazine may be given to individual pigs in capsules, by stomach tube, or by dose syringe.

Control

Follow the swine-sanitation system. Move A-type farrowing houses at least once a week during warm weather. When exposed to sunlight and drying, larvae on previously shaded soil are killed.

Use only movable sun shelters. If a farrowing house also serves as a sun shelter, provide a back door. Open both doors to insure free air circulation and promote drying.

Like other roundworms in the digestive tract, nodular worms may be partially controlled by proper feeding. Because well-fed pigs do less foraging and rooting, they are not as likely to become infected with nodular worms as poorly fed animals.

BN-28219

Figure 16.—Nodules (arrows), caused by nodular worms on the inner surface of a pig's large intestine. (Slightly enlarged.)

The Whipworm

The whipworm, *Trichuris suis*, is 1-1/3 to 2 inches long. The slender portion of the worm that bears the head at the tip is about twice as long as the relatively thick part (fig. 17).

The head is deeply embedded in the lining of the cecum or colon, where the whipworm lives (fig. 18).

Life history

The females produce microscopic eggs that are passed in the feces and become infective within a month. The eggs develop more rapidly in summer than in winter.

Pigs become infected by swallowing infective eggs with feed or water, or while rooting in contaminated soil. The eggs hatch in the

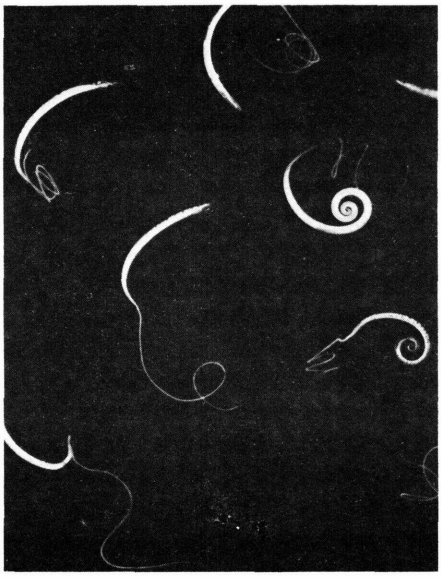

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Figure 17.—Whipworms removed from the intestine.

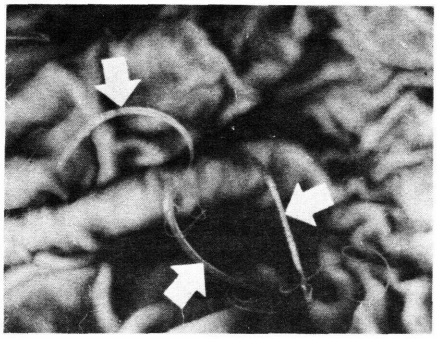

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Figure 18.—Whipworms (arrows) attached to the inner surface of the cecum. (Natural size.)

intestine and the larvae locate in the large intestine, where they develop to maturity in 4 to 7 weeks.

Damage

The delicate intestinal lining may become inflamed where worms are attached. Pigs that harbor a moderate number of whipworms show no signs of infection. Pigs with massive infections may be unthrifty, weak, and emaciated. Whipworm infection may kill young pigs.

Treatment

Hygromycin and dichlorvos are effective in removing whipworms. Use as directed for large intestinal roundworms (p. 10).

Prevention and control

Follow the swine-sanitation system (p. 5) to prevent and control whipworms.

Trichinae

Trichinae, *Trichinella spiralis*, are the slender threadworms that cause trichinosis in swine and humans. Trichinae may also infect rats, mice, dogs, cats, and other meat-eating animals.

The adult worms live in the small intestines. They are 1/16 to 1/6 inch long and about the size of a very fine thread. Migrating worms in the blood are microscopic in size. Encysted larvae in the muscles are not ordinarily visible without magnification. If the spirally coiled larval worm in the cyst is straightened, it measures about 1/25 inch long.

Life history

Adult trichinae in the intestines are short lived. Before they die and pass out with the feces, females deposit numerous young worms in the lymph spaces of the intestinal walls. From the lymph channels, the worms are carried through the heart, into the bloodstream, and then to all parts of the body. The young worms penetrate the muscle fibers and grow.

In about 3 weeks, the trichinae become spirally coiled and infective. A thin membrane or cyst about 1/50 inch in diameter forms around each worm. Occasionally, two worms are enclosed in a single cyst.

The encysted worm is trapped in muscles. It cannot develop further until the muscle tissue in which it is lodged is eaten by another susceptible animal.

Pigs get trichinae by eating scraps of raw or improperly cooked pork or the flesh of pigs, dogs, cats, rats, mice, and certain wildlife harboring encysted trichinae. Infected raw pork and carcasses of rats and mice are the usual sources of infection for dogs, cats, rats, and mice.

Humans most often get trichinosis after eating raw or imperfectly

cooked pork containing trichinae. Humans also get the disease by eating trichinous bear meat.

When a pig or other susceptible animal swallows flesh containing encysted trichinae, the young parasites are freed as the cysts are digested. These worms then move into the small intestine, grow to maturity in about 2 days, and begin producing larvae in about a week. Larvae migrate through the bloodstream to the muscles and become encysted (fig. 19).

Damage

Trichinosis is difficult to diagnose in the living hog. In many infections, hogs show no signs at all. When signs develop, they often are confused with those of other forms of parasitism or other diseases. Recently, however, sensitive diagnostic tests have been developed which can distinguish most cases of trichinosis from other diseases.

Hogs may go off feed a few days after eating large amounts of infected meat. At the time young worms

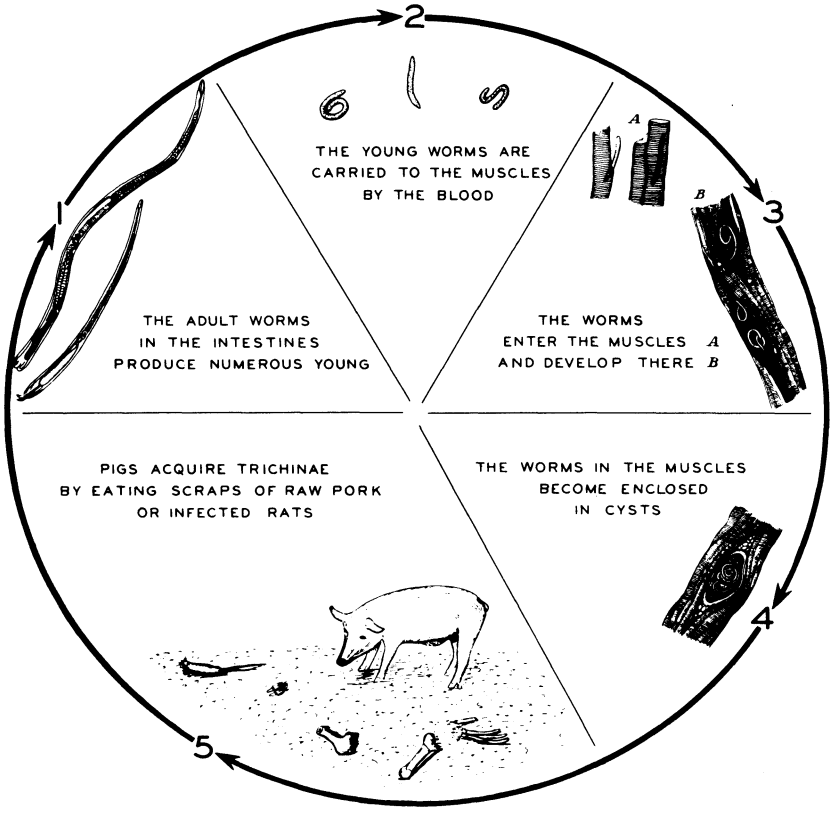

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Figure 19.—Life cycle of trichinae. (Worms greatly enlarged.)

invade the muscles (about 1 week after the animal becomes infected), hogs may move stiffly or lie motionless. Some may show edema of the eyelids.

These signs gradually disappear after the worms encyst in the muscles. The hogs regain their appetites and recover. Although the muscles appear grossly normal after recovery, encysted worms may remain alive for years.

Treatment

There is no practical treatment for trichinosis. Thiabendazole has been used experimentally, but it has little practical value for swine.

Control

Control of trichinosis in swine involves elimination of sources of infection. Application of the tests mentioned above could help greatly in tracing infected animals. The number of cases in the United States has been reduced since passage of laws requiring the cooking of all garbage fed to hogs.

Hogs still become infected if they eat uncooked pork or offal containing encysted trichinae.

Do not feed wildlife carcasses to swine.

Promptly dispose of any hogs that die by burying them deeply or by burning or rendering.

The Thorn-Headed Worm

The thorn-headed worm, *Macracanthorhynchus hirudinaceus*, is a milk-white to bluish cylindrical parasite that may be as large as a lead pencil.

The thorn-headed worm gets its name from a spiny snout, which it uses to attach itself to the gut (fig. 20). Worms hold so firmly that they are difficult to detach.

Life history

Adult female worms produce numerous eggs that pass out in the feces of infected pigs. White grubs—larvae of May beetles, or June bugs—eat the eggs along with feces and contaminated soil. Eggs hatch in the gut of the grubs, migrate into the body, and develop to the infective stage.

Pigs swallow the grubs while rooting in contaminated soil. Young worms escape from the grubs during digestion in the pig's stomach or intestines. These worms then settle down in the intestine and develop to egg-laying maturity in about 8 weeks (fig. 21).

Damage

No special signs are associated with thorn-headed worms, although these parasites are injurious. They contribute to general unthriftiness in parasitized pigs.

At the place the thorn-headed worm is attached to the intestinal wall, a swelling, or nodule, appears. This is visible on the outer coat of the intestinal wall at post mortem. Sometimes the injury is so deep that the intestine is perforated. This causes peritonitis, an often fatal inflammation of the delicate lining of the abdominal cavity.

Treatment

There is no satisfactory treatment for removing thorn-headed worms from infected pigs.

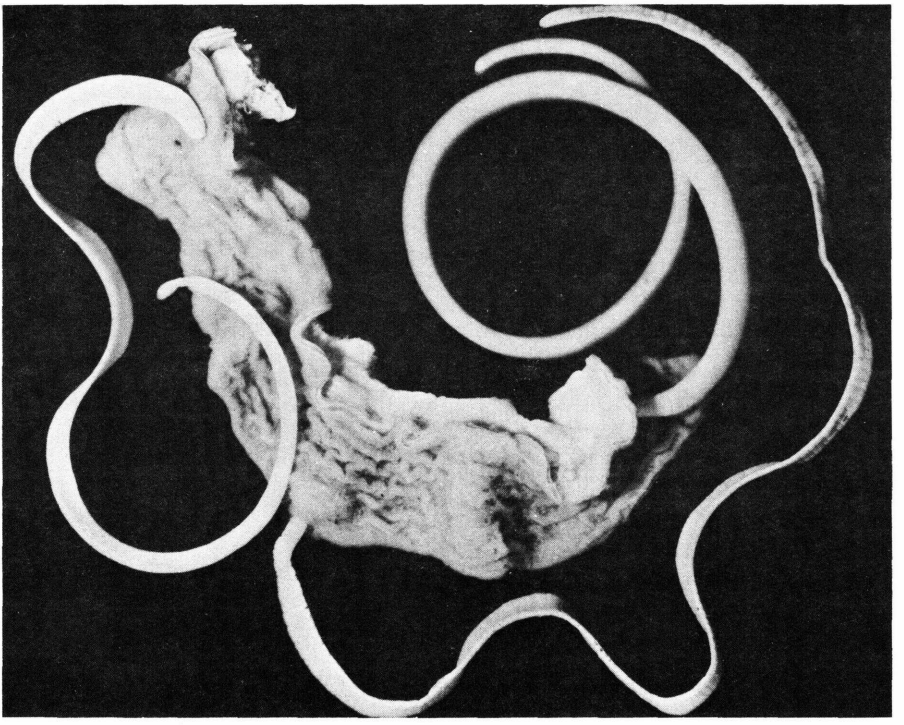

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Figure 20.—Thorn-headed worms protruding from intestine. (One-half natural size.)

Control

Ringing the noses of pigs and hogs tends to prevent rooting up infected grubs. Avoid old hog lots, straw piles, and permanent pastures. Follow the swine-sanitation system (p. 5).

TAPEWORMS

Hogs in the United States are not known to harbor adult tapeworms. However, they harbor one bladder worm that develops into an intestinal tapeworm in man and two that develop into tapeworms in dogs.

On casual examination, there is little resemblance between a bladder worm and an adult tapeworm. Actually, a bladder worm is an incompletely developed tapeworm. It has a fully formed head and neck, four cup-shaped suckers, and sometimes hooks—just as the tapeworm has. The head and neck are inverted into the thin-walled bladder, like the tip of a glove finger that is pushed in at one end. The bladder is filled with a clear fluid; the inverted head and neck appear as an opaque spot within the bladder.

The bladder worm completes its development into a tapeworm only when it is eaten by the appropriate host. In the host, the bladder worm turns its head outward and becomes attached to the intestinal wall. Then the worm begins to grow by producing segments. These form a long

jointed, flattened, whitish tapeworm in about 2 months.

The Pork Bladder Worm

The pork bladder worm is the immature stage of the tapeworm, *Taenia solium*, which infects man.

This bladder worm is spherical- to lemon-shaped and 1/5 to 2/5 inch in diameter (fig. 22).

It lodges in the heart (fig. 23), tongue, and other muscles. It has also been found in the brain, eyes, liver, lungs, pancreas, and spleen. Pork infected with bladder worms is called measly pork.

The pork bladder worm is rare in hogs in the United States. As pork bladder worms have decreased in hogs, there has been a corresponding decrease in these tapeworms in man.

Life history

Man acquires the pork tapeworm by eating raw or incompletely cooked pork containing this bladder worm.

In the human stomach, the worm's head and neck are pushed outside its bladder, which remains behind and is

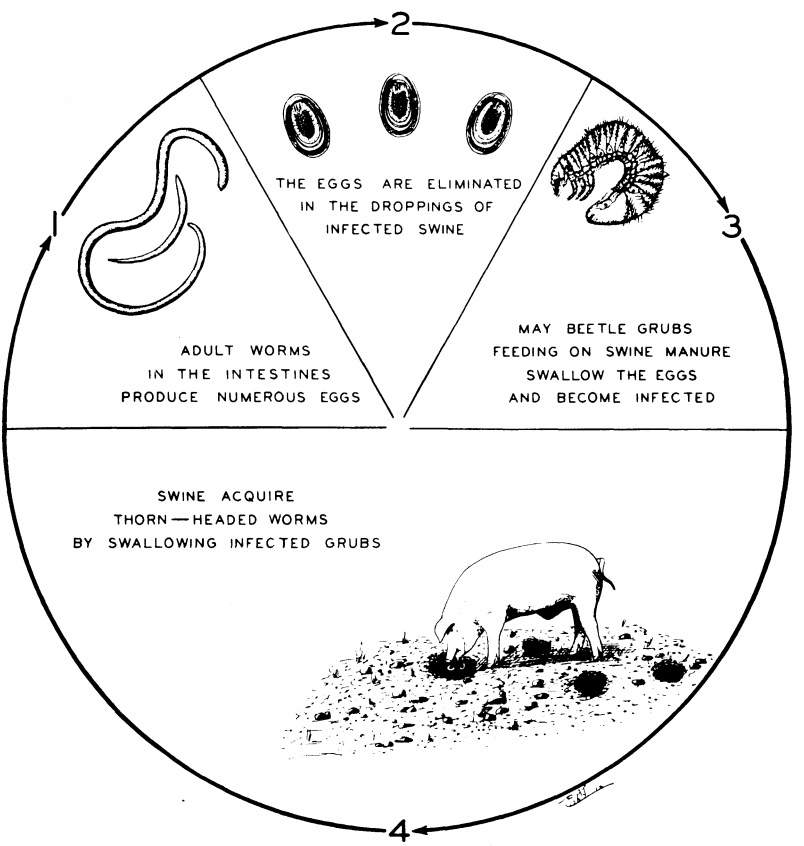

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Figure 21.—Life cycle of thorn-headed worm.

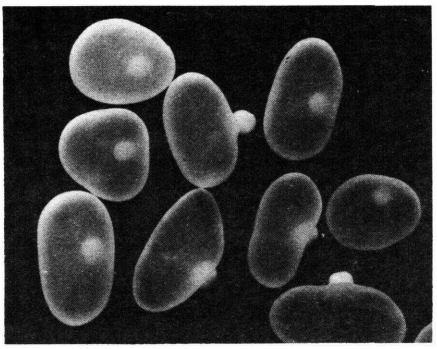

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Figure 22.—Pork bladder worms removed from muscles. (Natural size.)

digested. The living head and neck reach the small intestine where the parasite attaches itself to the intestinal wall with suckers and hooks.

The tapeworm grows by developing segments from its neck. The longest segments—at the tail of the tapeworm—are 1/2 inch long and 1/3 inch wide. After about 2 months, the tapeworm may be 6 or more feet long (fig. 24).

Segments become detached from the end of tapeworm chain and are expelled with droppings. Segments from mature tapeworms contain eggs.

Pigs become infected by swallowing either eggs or egg-filled segments. The eggs hatch in the pig's digestive tract, releasing infective bodies that are capable of movement and are equipped with hooks. These bore into the stomach wall and are carried by the blood to various parts of the pig's body, where they develop into bladder worms.

Thorough cooking will destroy bladder worms.

Damage

Infected hogs show no signs of bladder worm infection during life.

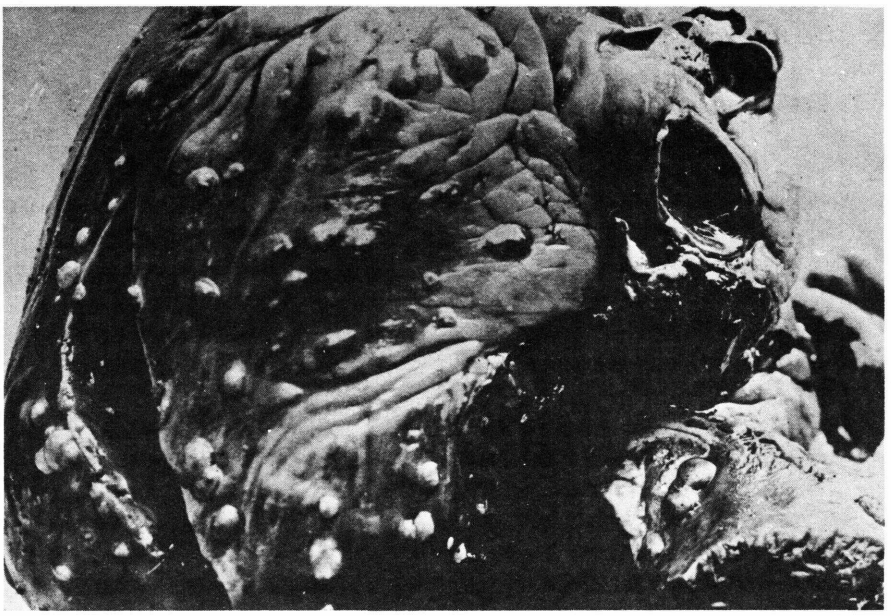

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Figure 23.—Measly pork: Heart heavily infected with pork bladder worms.

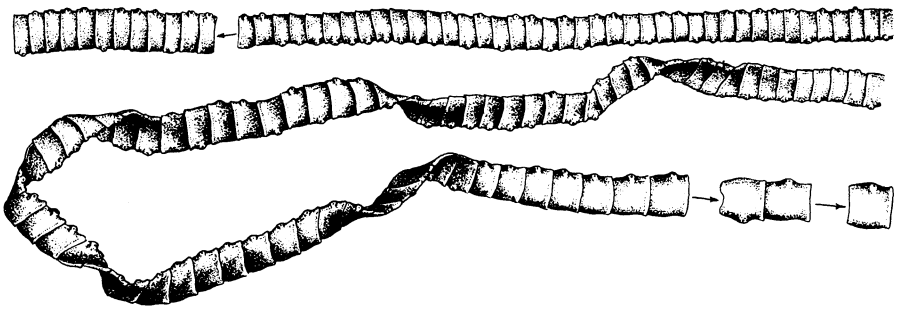

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Figure 24.—Portions of pork tapeworm from a human intestine. (One-half natural size.)

Normally, the infections are discovered on post mortem examination.

Because of the danger to humans from raw or imperfectly cooked measly pork, Federal meat inspectors take special precautions to detect and cut out infected portions of carcasses. If damage is general, the carcass is condemned.

Treatment

No practical treatment is known for destroying bladder worms in the live hog.

Prevention

Proper sanitation can prevent bladder worm infection in hogs and proper cooking of pork can prevent tapeworm infections in man.

The bladder worm is seldom found in hogs unless the level of human sanitation are below accepted standards. Proper disposal of human excreta will aid in preventing tapeworm and bladder worm infections.

The bladder worm—as well as the tapeworm—can occur in man. If a human swallows parasite eggs or becomes reinfected by the larvae in his own body, bladder worms develop in the muscles. Occasionally, the worms are found in the eye. If they lodge in the brain, they may cause epilepsy.

The Thin-Necked Bladder Worm

The thin-necked bladder worm, *Taenia hydatigena*, occurs in hogs, cattle, and sheep. It usually is about 1 inch in diameter, but may grow much larger (fig. 25).

Life history

The life history of this worm is similar to that of the pork tapeworm, except that dogs harbor the adult worms.

Dogs become infected by swallowing live thin-necked bladder worms, which develop into adult tapeworms in the intestine. Infected dogs can contaminate hog pastures and lots. In turn, hogs—or cattle or sheep—become infected by swallowing the tapeworm eggs or segments while grazing.

After this bladder worm has developed in a hog, it embeds itself in the

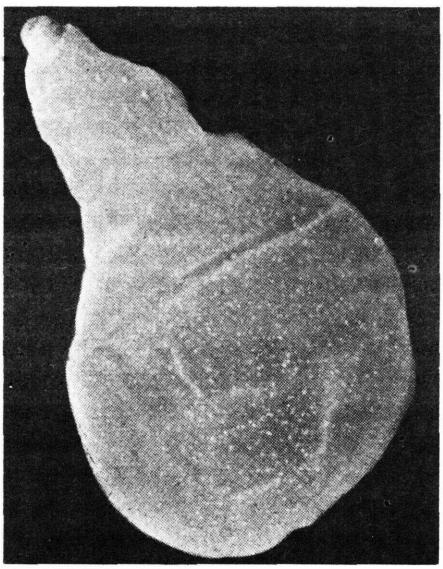

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Figure 25.—Thin-necked bladder worm. (Natural size.)

liver, attaches itself to the abdominal organs, or lives unattached in the abdominal cavity.

Damage

Infections with thin-necked bladder worms cannot be diagnosed in living hogs. A light infection causes little damage. Heavy infections are said to kill young animals.

Treatment

No practical treatment is known for removing thin-necked bladder worms from hogs or for destroying them in live animals.

Prevention

Proper disposal of infected carcasses is important in preventing the spread of bladder worms.

Burn or bury deeply the inedible parts of all hogs killed on farms and in country slaughterhouses. Do not let dogs have access to carcasses or offal. Keep dogs out of hog pastures and lots. Treat dogs regularly to remove tapeworms, if necessary.

Under Federal meat inspection, parts affected by thin-necked bladder worms are condemned.

The Hydatid

The hydatid, *Echinococcus granulosus*, is a bladder worm that produces cysts in the liver, lungs, or other vital organs. It also infects sheep, cattle, horses, and—in some foreign countries—man.

The hydatid spends part of its life as a tapeworm in a primary host—a dog, cat, or other carnivorous animal.

Hydatids vary in size and shape. Those in hog livers (fig. 26) are usually small, but occasionally grow as large as an orange.

The hydatid's bladder is filled with a clear fluid containing minute objects that resemble grains of sand. These are brood capsules; each contains many heads. Each head can produce a tapeworm in the intestine of the primary host.

Each bladder worm may develop other bladder worms on the inside or the outside. Some are attached to the mother cyst. Each daughter bladder worm produces its own brood capsules.

Life history

The adult tapeworms in the intestine of a dog are about 1/5 inch long with three to five segments. Like other tapeworms, hydatids shed egg-filled segments that are eliminated with droppings.

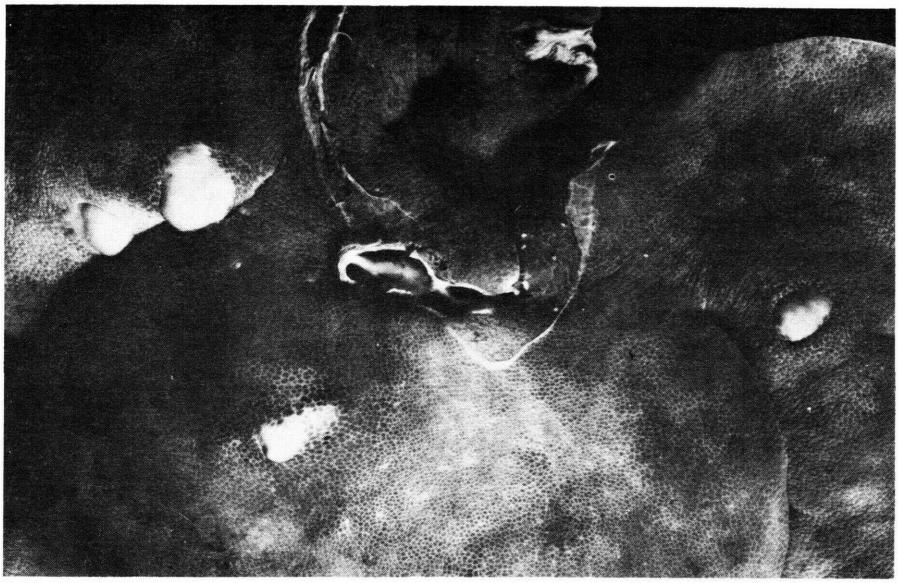

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Figure 26.—Hydatid lesions (white spots) on surface of liver.

Hogs get hydatids by swallowing feed or water contaminated with eggs or while rooting in comtaminated soil. The eggs hatch in the digestive tract and release invasive bodies that penetrate the walls of the alimentary canal. The bloodstream carries these young forms to the liver or other organs, where they become attached and develop into hydatids.

Dogs become infected by eating carcasses or offal from hogs containing hydatids (fig. 27).

Damage

Hydatids damage the organs in which they develop, but definitive signs of infection have not been recognized.

Treatment

No practical treatment is known for removing hydatids from hogs. Dogs can be treated for the tapeworms with arecoline hydrobromide and arecoline acetarsol. The most effective drugs against *Echinococcus* are bunamidine hydrochloride and bunamidine hydroxynaphthoate, but both can be toxic in excitable dogs suffering from liver dysfunction. Consult your veterinarian for information on use.

Prevention

Follow the general procedures for preventing thin-necked bladder worms (p. 30). Keep dogs off hog pastures and lots.

In humans, hydatids are highly dangerous. A surgical operation is required to get rid of the worms. Measures to prevent hydatids in hogs and other farm animals and the treatment of dogs will help prevent the infection in man.

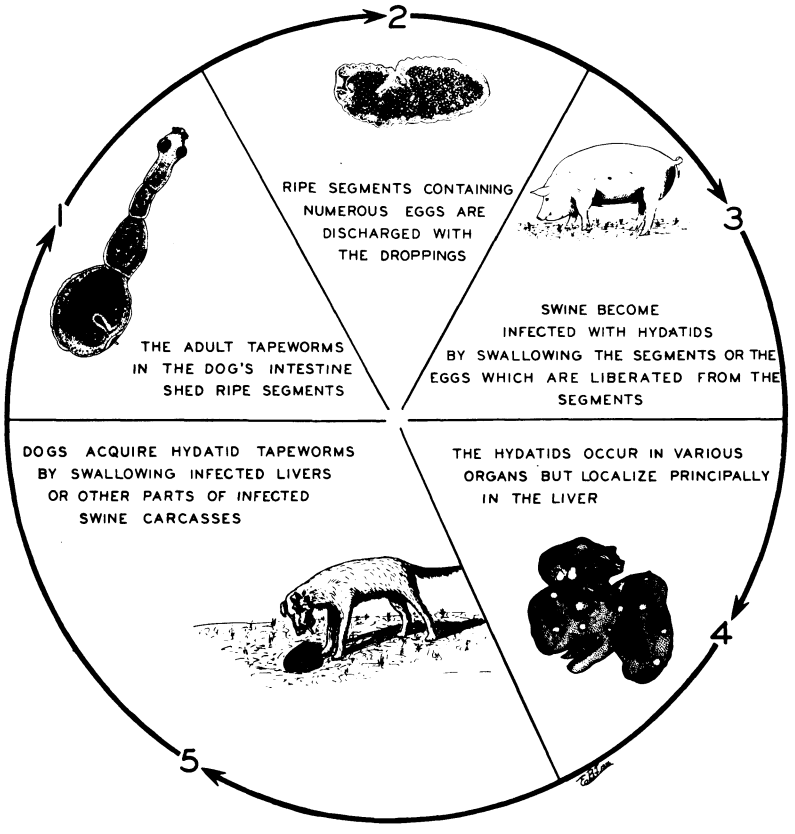

Figure 27.—Life cycle of hydatid tapeworm.

FLUKES

Some flukes are soft, flattened, leaflike worms; others are somewhat egg-shaped. They parasitize many species of animals. These worms have rather complicated life histories. They are transmitted from one animal to another through a snail and sometimes through an additional intermediate host, or carrier.

Only two kinds of flukes occur in swine in this country.

The Common Liver Fluke

The common liver fluke of sheep and cattle, *Fasciola hepatica*, may occur in hogs. The fluke is about 1 inch long and 1/2 inch wide; it lives in the bile duct and bile canals of the liver.

Liver flukes occasionally are found in hogs kept on low, swampy ground, where aquatic snails occur. Early development of flukes must take place in snails. Hogs pick up flukes

when they swallow green forage or water contaminated by flukes in the infective stage.

In areas that have high rates of infection in sheep and cattle, flukes also occur in hogs. These areas include the Pacific Coast and the Rocky Mountain and Gulf Coast States.

As a precaution, keep hogs off swampy or boggy pastures.

The Lung Fluke

The lung fluke, *Paragonimus rudi*, is a thick, egg-shaped worm about 1/5 to 3/5 inch long and up to 1/5 inch wide. It lives in sacs or cysts in lung tissue.

Life history

Eggs produced by flukes in the hog's lungs are coughed up, swallowed, and then discharged in the feces. These eggs hatch in swampy areas. Young flukes first develop in aquatic snails, then in crayfish.

Hogs on wet, boggy pastures acquire lung flukes by eating infected crayfish.

Once free in the digestive tract, the young flukes bore through the intestinal wall and wander to the lungs, which they penetrate. There they develop to egg-laying maturity.

Damage

Affected hogs do not show specific signs of infection.

Cysts located near the surface of the lungs appear as dark areas. If cysts are deep in the lungs, the surface may show only a swelling.

Treatment

No practical treatment is known.

Control

Keep hogs off wet, boggy areas that might harbor infected crayfish. If necessary, fence hogs out of such areas.

PROTOZOA

Protozoa are the simplest forms of animal life. The individual consists of an exceedingly minute speck of living matter. Some forms are free living; others are parasitic. The parasitic forms can be seen only with the aid of a microscope.

In spite of their small size, Protozoa can inflict damage. They cause some of the severest diseases that afflict humans—malaria, amebic dysentery, and African sleeping sickness.

Protozoan disease include anaplasmosis, babesiosis, genital trichomoniasis, and coccidiosis of livestock; and blackhead and coccidiosis of poultry.

Coccidia

Coccidia attack the lining of the intestines. They may cause scouring and damage the animal in other ways; the disease is known as coccidiosis. About six types of coccidia occur in swine in the United States.

The infective stages known as oocysts are microscopic in size. Oocysts are discharged in droppings of infected hogs. Unsanitary hog lots and poorly drained permanent pastures are ideal for the survival of oocysts. They must develop in the open before they can infect pigs.

Life history

In general, pigs acquire coccidia by swallowing oocyst-contaminated

feed, water, and soil. When an oocyst reaches the pig's intestines, it releases several infective bodies.

Each infective body penetrates a cell in the intestinal lining, which it destroys while producing several new infective bodies. These leave the cell, enter a neighboring cell and repeat the process.

Sooner or later, infective bodies stop multiplying and form oocysts that are discharged in the droppings. After development, oocysts infect hogs that swallow them.

Hogs that recover from coccidiosis may remain carriers. Because they continue to discharge oocysts for a long time, they may spread coccidia to susceptible pigs.

Damage

Pigs are particularly susceptible to coccidial infections.

Those with light infections do not usually show signs of coccidiosis.

Many infected pigs scour, become unthrifty, and lose weight.

In severe infections, the intestinal wall swells and becomes congested. The pig may lose weight and die.

Treatment

No uniformly reliable treatment has been established for coccidiosis.

Sulfonamides, such as sulfaquinoxaline, have shown promise.

Control

The control of coccidiosis is largely a matter of sanitation. Severe cases usually occur under crowded, unsanitary conditions.

Follow the swine-sanitation system (p. 5) to help prevent infection. Move infected pigs away from the area on which the coccidia were acquired to clean pastures or quarters.

Dysentery-Producing Protozoa

Hogs may harbor many forms of Protozoa in their intestines. One form, known as ameba, is almost indistinguishable from those that produce amebic dysentery in man. Another form, known as balantidia, apparently is identical with one found in man.

The dysentery-producing Protozoa are spread from pig to pig by tiny rounded bodies known as cysts. These cysts, which are the resistant stage in the life cycle of the parasite, are discharged in the feces. Pigs swallow them while eating or drinking.

Damage

Scientists do not know to what extent amebae injure pigs.

Balantidia damage the intestines and may cause scouring. They are most prevalent in hogs fed corn or garbage.

Treatment

No treatments have been developed for hogs with dysentery-producing Protozoa.

Control

Because of the possibility of transmission to humans, dysentery-producing Protozoa should be controlled in swine.

Control measures include keeping pigs in clean quarters or on clean pastures. Follow the swine-sanitation system (p. 5) and general recommen-

dations for parasite prevention and control (p. 6).

Trichomonads

Other Protozoa, known as trichomonads, are found in the intestine, stomach, and—sometimes—the nose.

These pear-shaped parasites are extremely tiny. They move by whip-like structures attached to one end of the body.

It is not known how trichomonads spread from one pig to another. However, pigs kept under unsanitary conditions generally harbor more of these parasites than clean pigs.

Damage

Ordinarily, trichomonads in the stomach and intestine do not cause serious injury. In heavy infections, they may cause scouring.

Treatment

No effective treatment is known for removing trichomonads.

Control

To control trichomonads, follow the swine-sanitation system (p. 5) and provide a clean environment for all pigs and hogs.

USE OF PESTICIDES

This publication is intended for nationwide distribution. Pesticides are registered by the Environmental Protection Agency (EPA) for countrywide use unless otherwise indicated on the label. The use of pesticides is governed by the provisions of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended. This act is administered by EPA. According to the provisions of the act, "It shall be unlawful for any person to use any registered pesticide in a manner inconsistent with its labeling." (Section 12 (a) (2) (G))

EPA has interpreted this Section of the Act to require that the intended use of the pesticide must be on the label of the pesticide being used or covered by a Pesticide Enforcement Policy Statement (PEPS) issued by EPA.

The optimum use of pesticides, both as to rate and frequency, may vary in different sections of the country. Users of this publication may also wish to consult their Cooperative Extension Service, State agricultural experiment stations, or county extension agents for information applicable to their localities.

The pesticides mentioned in this publication are available in several different formulations that contain varying amounts of active ingredient. Because of this difference, the rates given in this publication refer to the amount of active ingredient, unless otherwise indicated. Users are reminded to convert the rate in the publication to the strength of the pesticide actually being used. For example, 1 pound of active ingredient equals 2 pounds of a 50 percent formulation.

The user is cautioned to read and

follow all directions and precautions given on the label of the pesticide formulation being used.

Federal and State regulations require registration numbers. Use only pesticides that carry one of these registration numbers.

USDA publications that contain suggestions for the use of pesticides are normally revised at 2-year intervals. If your copy is more than 2 years old, contact your Cooperative Extension Service to determine the latest pesticide recommendations.

The pesticides mentioned in this publication were federally registered for the use indicated as of the issue of this publication. The user is cautioned to determine the directions on the label or labeling prior to use of the pesticide.

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